

Energy Security of the Largest Asia Pacific Countries: Main Trends

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(Abstract) The paper addresses the problems of energy security of the largest Asia Pacific countries. The situation related to a steadily growing share of nonrenewable energy resources in the structure of primary energy consumption in the region cannot be considered favorable. The stable trend towards increase in the dependence of the region on external supplies of the considered resources (almost 8% by 2030) is obviously indicative of possible substantial decrease in the level of energy security of the Asia Pacific region (APR). The level of energy security in APR can be increased only through more intensive development of renewable energy sources and considerable increase in their share in the structure of consumed primary energy.

Keywords: Energy security; APR countries; energy resources; structure of primary energy consumption.

1. INTRODUCTION

Energy security is provided, on the one hand, by adequate supply of energy resources and, on the other hand, by moderate demand which is met by efficient energy consumption. The key aspects of energy security are country specific. The most important energy security aspect for the countries with insufficient energy resources is first of all reliable and guaranteed external supply of the required amount of different energy resources [1]. For the countries that are provided with energy resources to some extent an important aspect of energy security is energy independence or ability to meet their demand by their own resources in case of decrease in the external energy supplies.

2. SPECIFICS OF WORLD DEMAND FOR PRIMARY ENERGY

2.1 World demand for primary energy in whole

The main reason for exacerbation of the energy security situation in the world in the last decades is persistence of two global processes. First of all this is a considerable rise in demand for primary energy in the world, which is especially fast in developing countries (**Table 1**) where the specific energy – GDP ratio is very high, and in transition economies (the FSU, including Russia, and other European countries – former CMEA members). Secondly, this is exhaustion of relatively cheap natural energy resources in most regions of the world and the need to develop their more expensive reserves, which will require considerable investment in the energy sector.

Table 1. World demand for primary energy, mln toe [2]

Regions, largest countries	Year			Change 2011 over, %	
	2005	2010	2011	2010	2005
US	2351.2	2277.9	2269.3	-0.4	-3.5
Canada	326.8	315.7	330.3	4.6	1.0
Mexico	161.1	170.4	173.7	2.0	7.8
Total North America	2839.2	2763.9	2773.3	0.3	-2.3
Argentina	68.8	77.1	81.9	6.2	18.9
Brazil	207.0	258.0	266.9	3.5	29.0
Venezuela	71.0	85.4	89.1	4.4	25.5
Total S. & Cent. America	521.8	619.0	642.5	3.8	23.1
France	261.2	251.8	242.9	-3.5	-7.0
Germany	333.2	322.4	306.4	-5.0	-8.1
Russia	650.7	668.7	685.6	2.5	5.4
United Kingdom	228.2	209.0	198.2	-5.2	-13.2
Total Europe & Eurasia	2969.0	2938.7	2923.4	-0.5	-1.5
Iran	179.2	223.0	228.6	2.5	27.6
Saudi Arabia	151.6	202.1	217.1	7.4	43.2
United Arab Emirates	62.6	83.6	87.2	4.2	39.1
Total Middle East	562.5	716.5	747.5	4.3	32.9
Algeria	32.6	38.6	40.9	6.2	25.5

Egypt	62.5	81.0	82.6	2.0	32.2
South Africa	113.5	124.4	126.3	1.5	11.2
Total Africa	327.0	382.2	384.5	0.6	17.6
Australia	117.8	115.0	123.3	7.2	4.7%
China	1659.0	2402.9	2613.2	8.8	57.5
Indonesia	118.8	148.8	148.2	-0.4	24.7
Japan	527.1	503.0	477.6	-5.0	-9.4
Malaysia	60.1	70.7	69.2	-2.1	15.2
South Korea	220.8	255.6	263.0	2.9	19.1
Thailand	88.9	104.3	106.0	1.6	19.2
Total Asia Pacific	3535.0	4557.6	4803.3	5.4	35.9
Total World	10754.5	11977.8	12274.6	2.5	14.1

Table 1 shows that the total consumption of primary energy in the world increased by 14% from 2005 to 2011. However, the situation varies by region of the world. The largest growth of consumption in relative units is observed in the Asia Pacific region (445% except Japan). A relatively small consumption growth is characteristic of the world regions with a large share of industrially developed countries, i.e. Europe and North America. The data of **Table 1** do not allow us to unambiguously assess whether the processes are negative or positive.

2.2 World demand for nuclear and renewable energy

On the one hand, a high rise in the primary energy consumption is observed in the countries with a relatively low level of economic development and this can be considered to be a positive trend. On the other hand, even if primary energy consumption rises in the industrially developed countries it can partly be met by renewable energy sources. The dynamics of change in consumption of renewable energy over the last six years can be estimated on the basis of data from **Table 2**. **Table 2**. Renewable and nuclear energy consumption by world region and by the largest country in 2011, TWh (Terawatt-hours)

Regions of the World, largest countries	Nuclear & renewable	
	2011	Change 2011 over 2005
US	1360.3	14.6%
Canada	490.6	5.5%
Mexico	53.6	15.4%
Total North America	1904.5	12.1%
Argentina	47.9	0.2%
Brazil	478.4	30.8%
Venezuela	83.7	8.3%
Total S. & Cent. America	815.5	21.6%
France	506.6	-0.6%
Germany	229.9	1.9%

Russian Federation	338.4	4.9%
United Kingdom	104.0	5.6%
Total Europe & Eurasia	2364.3	6.8%
Iran	12.2	-7.0%
Saudi Arabia	0.0	0.0
United Arab Emirates	0.0	0.0
Total Middle East	22.3	-6.0%
Algeria	0.4	-31.9%
Egypt	15.1	14.7%
South Africa	15.0	8.1%
Total Africa	121.9	14.8%
Australia	20.2	11.9%
China	858.7	88.9%
Indonesia	24.9	43.0%
Japan	280.7	-29.9%
Malaysia	7.4	42.9%
South Korea	158.0	4.7%
Thailand	15.2	54.9%
Total Asia Pacific	1778.9	31.3%
TOTAL WORLD	7007.3	15.5%

The fastest growth of renewable energy consumption is observed in the Asia Pacific region and in the countries of South and Central America (due to development of hydro and other renewable energy resources).

2.3 The share of nuclear and renewable energy sources in primary energy consumption in APR

At the same time in 2005-2011 the share of nuclear and renewable sources in primary energy consumption of the world virtually did not change and remained at the level of 13%. The same situation is observed in the world regions. For example for the entire North America this share increased only by 2.1% (from 13.4% to 15.5%), for Europe and Eurasia – by 1.6% (from 16.7% to 18.3%). In the regions of South and Central America, Middle East, Africa and APR this share did not change at all and made up 28%, 0.7%, 7% and 8-9%, respectively. The data [2] demonstrate the following situation in the largest APR countries (**Table 3**). Comparison of data from **Tables 1** and **3** makes it possible to assess changes in the dependence of the largest APR countries on supplies of the main types of nonrenewable primary energy: coal, heavy oil, and natural gas in 2005-2011 (**Table 4**).

Table 3. The share of nuclear and renewable energy sources in primary energy consumption in the largest APR countries

Country	2005	2011
Australia	3.6%	3.7%
China	6.6%	7.4%
Indonesia	3.4%	3.8%
Japan	18.5%	13.3%
Malaysia	3.6%	2.5%

South Korea	15.3%	13.6%
Thailand	2.5%	3.2%
Total Asia Pacific	9.1%	8.4%

Table 4. Relative values of change in the primary energy consumption and share of nuclear and renewable resources in this consumption in the largest APR countries

Country	Change 2011 over 2005	
	Primary energy consumption	Share of renewable energy resources
Australia	4.7%	3.7%
China	57.5%	7.4%
Indonesia	24.7%	3.8%
Japan	-9.4%	13.3%
Malaysia	15.2%	2.5%
South Korea	19.1%	13.6%
Thailand	19.2%	3.2%
Total Asia Pacific	35.9%	8.4%

Analysis of data from **Table 4** shows a dynamic increase in consumption of nonrenewable primary energy in all Asia Pacific countries (except Japan) at maintenance or even decrease in the share of renewable energy in the total primary energy consumption.

3. DEPENDENCE OF THE LARGEST APR COUNTRIES ON IMPORTED PRIMARY ENERGY

3.1. Dependence on imported oil

According to the information of the World Energy Agency [3], by 2030 consumption of primary energy in the world may increase up to 17 billion toe and in the Asian region – up to 8 billion toe. Despite this fact the anti-nuclear sentiments related to the problems of nuclear energy security, radioactive waste storage and burial are still very strong. The situation was to a great extent exacerbated after the emergency at the Fukushima NPP. Thus, the main load in the growing consumption of primary energy again falls on traditionally used gas, oil and coal.

Almost all oil in the APR countries after refining is used for transport purposes. Therefore, we will consider the situation with the dependence of the largest APR countries consuming energy on external oil supplies, **Table 5**.

Table 5. Dependence of the largest APR countries on imported oil

Country	2011		Dependence on imported oil	
	Product.	Consumpt.	2005	2011
	Million toe		%	
Australia	21.0	45.9	36	54
China	203.6	461.8	45	56
Indonesia	45.6	64.4	11	29

Japan	0	201.4	100	100
Malaysia	26.6	26.9	-38	1
South Korea	0	106.0	100	100
Thailand	13.9	46.8	77	70
APR, total	388.1	1316.1	67	71

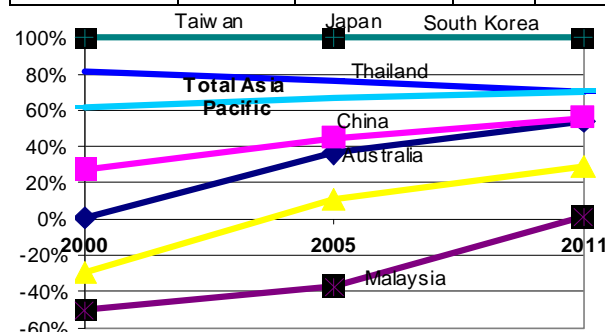


Figure 1. Change in dependence of the largest APR countries on external oil supplies

Data from **Table 5** are indicative of the reliance of the APR countries on imported oil (Japan and South Korea are totally dependent). **Figure 1** shows the tendencies towards increase in the dependence of some countries and region as a whole. Only in Thailand, against the background of increasing oil production, there are tendencies towards inconsiderable decrease in this dependence. Reduction in oil production made Indonesia, the country independent of oil import, also import oil, and this dependence dynamically increases. In Malaysia, the country that has been provided with local oil until now, the possibilities of oil export have decreased by more than twice over the last decade. A persistent tendency towards increase in dependence on oil import can be seen in the entire APR. This is confirmed by the data in **Figure 2** that was constructed on the basis of [4]. According to this scenario, by the year 2030 the demand for oil in the region can increase by 1.4 times against 2010 with a 1.3-fold reduction in oil production in the region in the same year. Thus, the dependence of the region on external oil supplies can rise from 71% today to 83% in 2030.

3.2. Dependence on imported primary energy (except oil)

Now let us focus on the rest of the resources consumed to produce different types of energy. **Table 6** shows how the demand for primary energy (except oil) is met in the countries, major energy consumers in APR.

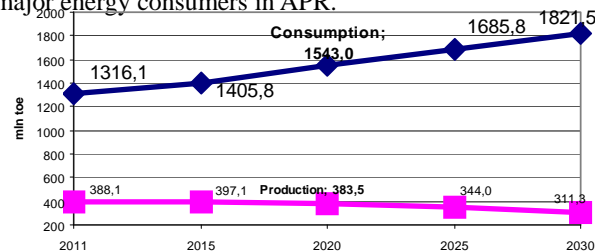


Figure 2. Forecast of oil production and consumption in APR until 2030 [4]

Table 6. Production and consumption of primary energy (except oil) in the largest countries of APR in 2011, million toe [2]

Country	Production					Consumption (total)	Surplus, shortage (-)	Relative shortage
	Natural gas	Coal	Nuclear Energy	Hydro electricity	Renewable			
Australia	40.5	230.8	-	2.4	2.2	275.8	77.4	198.4
China	92.3	1956.0	19.5	157.0	17.7	2242.6	2151.4	91.2
Indonesia	68.0	199.8	-	3.5	2.1	273.5	83.7	189.7
Japan		0.7	36.9	19.2	7.4	64.2	276.2	-212.0
Malaysia	55.6		-	1.7	^	57.3	42.4	14.9
South Korea		0.9	34.0	1.2	0.6	36.7	157.1	-120.4
Thailand	33.3	6.0	-	1.8	1.6	42.7	59.2	-16.5
APR, total	431.2	2686.3	108.0	248.1	46.4	3520.0	3487.2	32.7

Comparison of possibilities of primary energy production (except oil) and scale of their consumption by country shows the countries that depend on the external energy supplies to the greatest extent. These are Japan, South Korea, and Thailand. The rest of the countries given in **Table 6** can be subdivided into the following groups:

- the countries that satisfy their demand for gas and coal by local resources and export them (Australia, Indonesia);
- the countries that partly import some resources (China imports some amount of gas, Malaysia - some amount of coal) but have equivalent reserves of other kinds of resources (for China it is coal and for Malaysia – gas).

On the whole, if not to consider oil fuels, the Asia Pacific region can be considered as a self-sufficient region.

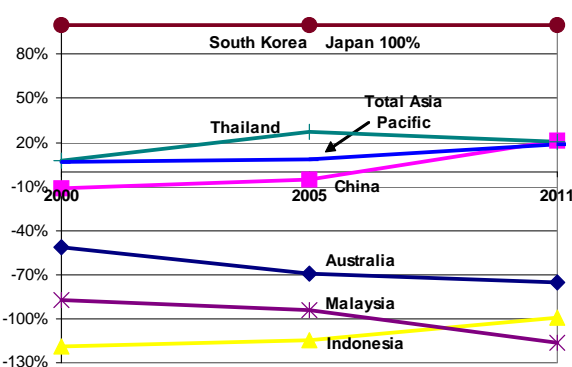
Let us exclude oil fuels from consideration and focus on the tendencies that emerge in the region with respect to the gas and coal use, **Table 7**.

Now consider the dynamics of change in the coal and gas dependence of the countries, major consumers of primary energy in the region (**Figures 3, 4**).

The countries that are completely provided with their own natural gas and exported it through the entire period at issue are: Indonesia, Malaysia and Australia. The countries that consume imported gas and gradually get dependent on its import are China and Thailand (the same can be said about the whole region). Japan and South Korea consume only imported natural gas.

Table 7. Share of coal and gas in primary energy consumption (except oil)

Country	Year		
	2000	2005	2011
Australia	94%	95%	94%
China	93%	92%	91%
Indonesia	92%	93%	93%
Japan	63%	68%	77%
Malaysia	93%	97%	96%
South Korea	70%	71%	77%
Thailand	94%	95%	94%
Total Asia Pacific	85%	87%	88%

**Figure 3.** Changes in dependence of the largest APR countries on external natural gas supplies

As far as coal is concerned, the considered countries can be divided into three groups: pure exporters (Australia, Indonesia); China had 6% of domestic coal reserves in 2011; and the countries that depend on imported coal to a greater extent (Thailand is getting more dependent and Japan, Malaysia and South Korea are almost totally dependent). However, it should be noted, that the coal share in consumption of primary energy (except oil) in Malaysia is less than 9%.

The generalized data characterizing the dependence of the largest APR countries on external coal and natural gas supplies are presented in **Table 8**.

**Figure 4.** Change in the dependence of the largest APR countries on the external coal supplies

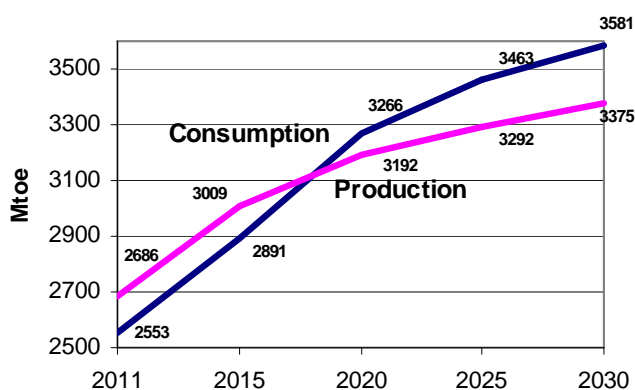
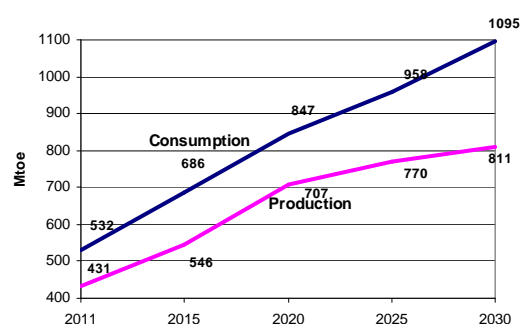
Table 8. Dependence of the largest APR countries on imported coal and natural gas

Country	Production			Consumption			Dependence on external supplies		
	2000	2005	2011	2000	2005	2011	2000	2005	2011
	million toe						%		
Australia	194.5	239.2	271.2	65.2	73.4	72.9	-198%	-226%	-272%
China	787.0	1346.6	2048.3	759.2	1260.8	1957.1	-4%	-7%	-5%
Indonesia	106.0	158.0	267.9	40.5	55.4	78.1	-162%	-185%	-243%
Japan	1.7	0.6	0.7	163.9	192.0	212.7	99%	100%	100%
Malaysia	40.7	55.0	55.6	23.6	34.6	40.7	-72%	-59%	-37%
South Korea	1.9	1.3	0.9	60.0	82.1	121.3	97%	98%	99%
Thailand	23.4	27.1	39.3	27.6	40.5	55.8	15%	33%	30%
APR, total	1392.0	2146.9	3117.4	1418.8	2120.6	3084.7	2%	-1%	-1%

Table 9. Consumption structure of primary energy resources (without oil) in APR countries in 2011

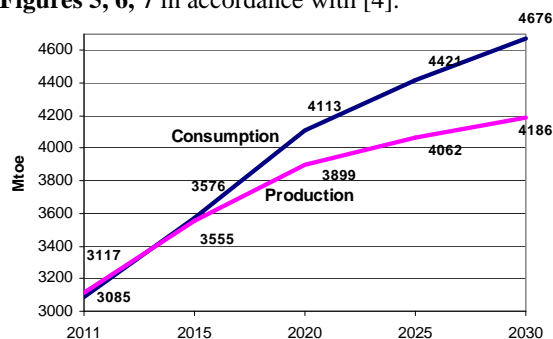
Country	Share of consumption				
	Natural gas	Coal	Nuclear energy	Hydro electricity	Renewable
Australia	29.8	64.3	0.0	3.1	2.8
China	5.5	85.5	0.9	7.3	0.8
Indonesia	40.8	52.5	0.0	4.2	2.6
Japan	34.4	42.6	13.3	7.0	2.7
Malaysia	60.6	35.5	0.0	4.0	0.0
South Korea	26.7	50.6	21.6	0.7	0.4
Thailand	70.8	23.4	0.0	3.1	2.7
APR, total	15.2	73.2	3.1	7.1	1.3

Consumption structure of primary energy resources by type without oil for the considered countries is shown in **Table 9**.

**Figure 5.** Forecast of coal production and consumption in APR by 2030**Figure 6.** Forecast of natural gas production and consumption in APR by 2030

The share of the resource dominating consumption structure of energy resources is given in **Table 9** in bold type. Coal prevails in all the analyzed countries except Malaysia and Thailand, natural gas – in Malaysia and Thailand. A rather high share of natural gas in Malaysia is explained by its sizable own production.

The basic trends in coal and natural gas production and consumption for the whole region are presented below in **Figures 5, 6, 7** in accordance with [4].

**Figure 7.** Forecast of production and consumption of coal and natural gas in total in APR by 2030

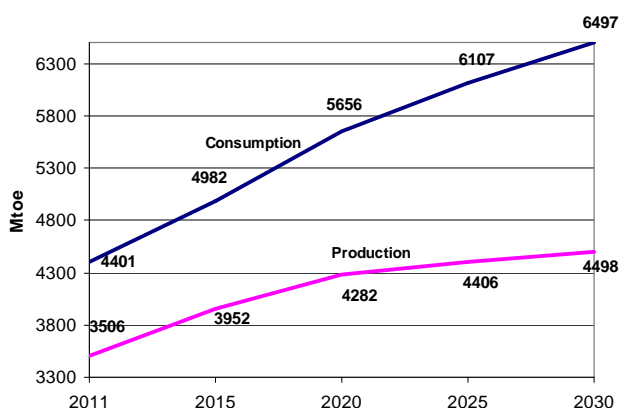


Figure 8. Forecast of production and consumption of oil, coal and natural gas in total in APR by 2030

Analysis of **Figures 5, 6, 7** shows that if the excess of own coal production in the region over its total consumption was equal to 5% in 2010, its dependence on external coal supplies will make up about 1% by 2030 for the considered scenario of development. As concerns natural gas, the situation can change as follows: if dependence on external gas supplies is 19% now, it can increase to 26% for the considered scenario. In the analysis of production and consumption of coal and natural gas in total the currently self-sufficient region will have to import above 10% of its total coal and natural gas consumption from the other world regions.

3.3. Dependence on external supplies of primary energy

All the projected data on production and consumption of oil, coal and natural gas being combined, the expected degrees of the region's dependence on external supplies of primary energy will be obtained, **Figure 8**.

Based on the data of **Figure 8** it is easy to calculate that the dependence of the region on external supplies of coal and hydrocarbons that account for 20% can increase even to 31% by 2030 for the considered development scenario.

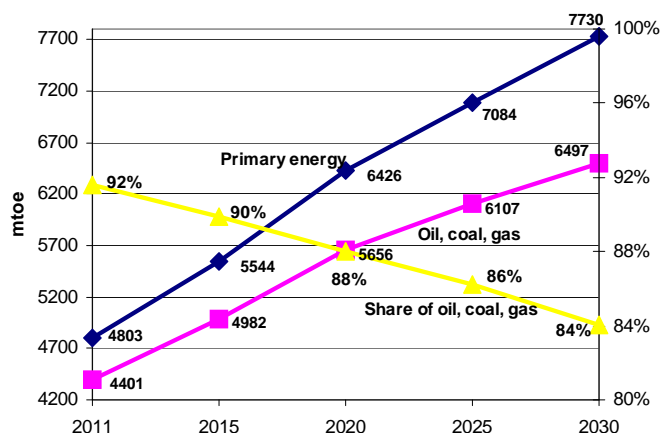


Figure 9. Forecast of primary energy consumption; the share

of nonrenewable energy resources in the general structure of primary energy consumption in APR by 2030

At the same time by 2030, according to the analyzed development scenario, the share of nonrenewable energy resources (coal, gas, oil) in the total consumption of primary energy in the region can decrease from 92% now to 84%, **Figure 9**).

4. CONCLUSIONS

The situation related to a steadily growing share of nonrenewable energy resources in the structure of primary energy consumption in the region cannot be considered favorable in the light of depletion of these resources. However, this process, in combination with the stable trend toward increase in the dependence of the region on external supplies of the considered resources (almost 8% by 2030), is obviously indicative of possible substantial decrease in the level of energy security of APR as a whole. Apparently, indirectly, due to intensification of antinuclear sentiment, the situation at NPP "Fukushima" can be an additional negative factor in that process.

From the above said it follows that the level of energy security in APR can be increased only through more intensive development of renewable energy sources and considerable increase in their share in the structure of consumed primary energy. It is crucially important for Japan, South Korea and for dynamically developing China, i.e. the countries short of primary energy resources.

As to oil, only Malaysia has a sufficient potential to remain oil-independent so far. In other countries such dependence will apparently gradually decrease owing to more active use of hybrid or fully electric vehicles.

REFERENCES

- [1] Detection of "bottlenecks" and ways to overcome emergency situations in gas transportation networks on the example of the European gas pipeline network
N.I. Voropai, S.M. Senderov, A.V. Edelev. Energy 42 (2012), pp. 3-9.
- [2] BP Statistical Review of World Energy: June 2012 // <http://www.bp.com/statisticalreview>.
- [3] International Energy Outlook 2010 // <http://www.iea.org/weo/>.
- [4] BP Energy Outlook 2030: January 2012 // <http://www.bp.com/energyoutlook2030>